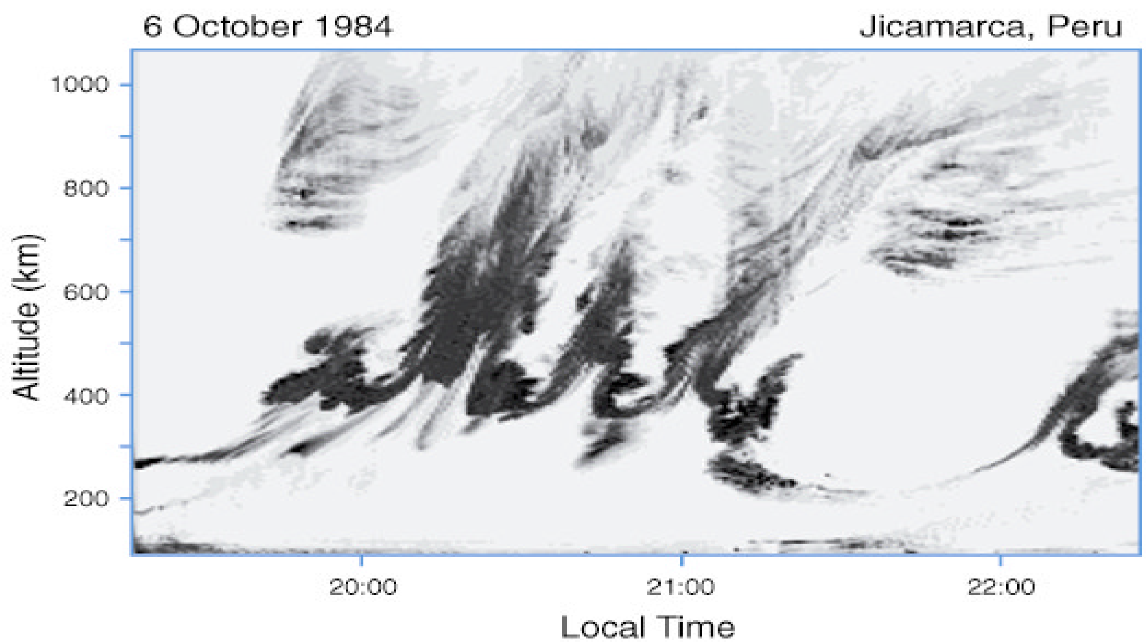
Ionospheric Mappers



Radar map of equatorial electron density variations at 3-meter scale lengths. These irregularities disrupt communication and navigation systems.

IM Mission Goals and Objectives

The integrated science and space weather goals for the IM mission are:

- Global characterization and understanding of the Earth's ionosphere and upper atmosphere and its connection to the Sun, solar wind, and magnetosphere
- Major improvements of ionospheric and thermospheric specification models
- Improvement of forecast and nowcast accuracy
- Establishment of a quantitative baseline for Sun-climate studies

IM Major Science Questions

<u>The IM Mission will address three main areas of space weather effects:</u>

Human Radiation Exposure

- How do global temporal and spatial distributions of energetic particle precipitation relate to the magnetosphere and solar wind drivers?

Impacts on Space Systems and Technology

- What are the sources, dynamics, and evolution of plasma instabilities and small-scale irregularities that create HF and GPS scintillations?
- How does EUV variability and geomagnetic storms drive plasma density behavior, including those at high, mid, and low latitudes?
- How do solar heating and magnetospheric forces create neutral density variations and cellular structure and how do they evolve?
- How are ionospheric currents, including field-aligned current closure, created?

Global Climate Change

- What is the best way to establish highly-accurate global parameters for Sun-climate baseline measurements and how does the ionosphere/thermosphere system reflect long-term Sun-climate variability?

IM Approach/Methodology

One problem with obtaining data from a single satellite is that average conditions over a long time span smooth out variations and mask abrupt, large-scale spatial changes.

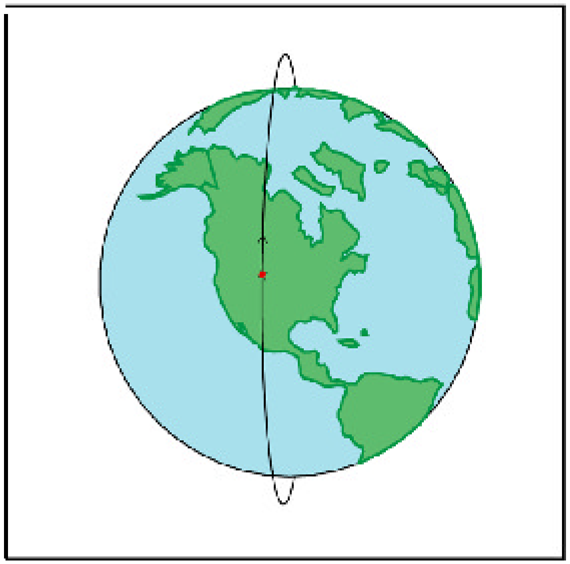
The approach of the IM mission is to gather simultaneous, global data of key space weather-related ionospheric parameters using multiple, identical spacecraft distributed in latitude and local time. Data from these instruments will be used to:

- Create space-time maps of the ionosphere including neutral density and drag effects, plasma density, irregularities, impulsive radiation input, GPS and HF scintillations, currents, winds, and plasma drifts
- Measure large-scale variations and auroral energy input
- Develop physical models to predict space weather parameters
- Dramatically improve both empirical and predictive ionospheric models

Both in-situ and imaging platforms are needed to achieve these goals.

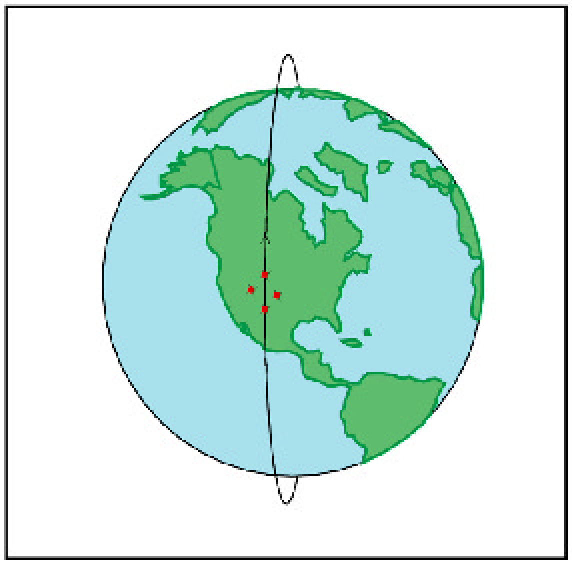
IM Concept Evolution

Single Satellite



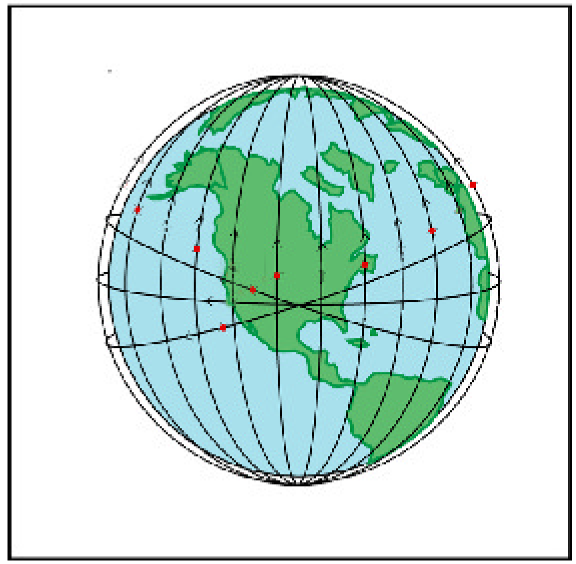
- Event studies, exploration
- Provide average global conditions
- Example: **Dynamics Explorer-2**

Cluster of Satellites



- Event studies that separate space and time
- Provide refined average global conditions
- Example: **Geospace Electrodynamics Connections**

Global Network of Satellites



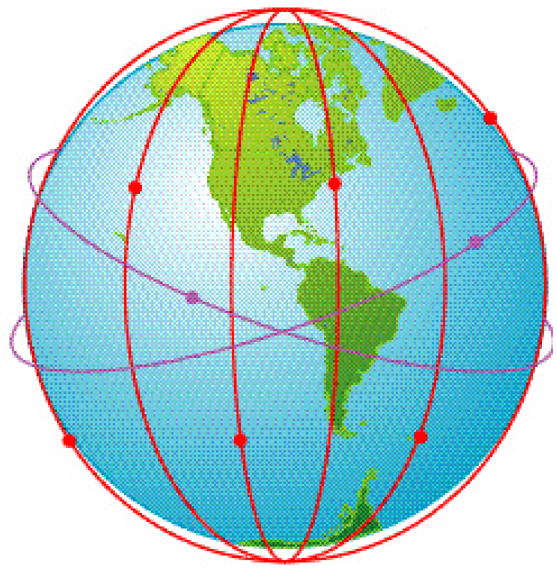
- Global coverage with simultaneous observations at all latitudes and local times
- Uncovers global-scale processes, coupling to other regions; provides event studies in "big picture"
- Enable tomography and other RF experiments (e.g., GPS occultations)
- Example: **Ionospheric Mappers**

Ionospheric Mappers

***In situ* satellites at 450 km circular orbits**

6 Polar orbiting satellites

2 Low inclination (e.g., 30   ) satellites



- Figure shows all 8 satellites in one hemisphere.
- “Station Keeping” can be used to maintain equal spacing (e.g., 4 satellites on dayside, 4 on nightside; all 6 polar satellites crossing polar regions together, etc.).

IM In-Situ Mission Characteristics

Low Inclination Elements

- Launch from Eastern Range in 2009
- Small-class launch vehicle with dual payload adapter
- Low-inclination, 450-km circular orbit
- 2-year mission design life with 5 years of on-orbit operations
- Two identical small three-axis stabilized spacecraft in same orbit plane
- Unique spacecraft development
- Five *in-situ* instrument packages per spacecraft with high TRL number
- Several ground stations

High Inclination Elements

- Launch from Western Range in 2009
- Medium-class launch vehicle with satellite dispenser
- 450-km circular polar orbits
- Six orbit planes, 30 degrees apart, is nominal configuration
- 2-year mission design life with 5 years of on-orbit operations
- Six identical small three-axis stabilized spacecraft (constellation)
- Unique spacecraft development
- Five *in-situ* instrument packages per spacecraft with high TRL number
- All instruments operating near 100% duty cycle
- Polar ground stations